Vogt Power Emission Control Solutions

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Vogt Power History

An Industry Leader with a Tradition of Innovation and Excellence

- 1880  Founded by Henry Vogt
- 1962  First HRSG
- 1972  First 3 pressure HRSG
- 1988  First Re-heat HRSG
- 1988  First F-class HRSG
- 2010  Fast Start Capabilities
- 2011  Simple Cycle Exhaust Systems
- 2013  Once Through Steam Generator

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Emission Control Solutions

Options for Gas Turbine Emission Control

• Simple Cycle Exhaust Catalyst System
• Combined Cycle HRSG Installation with Catalyst

• Steam Injection for NOx Control
The CO Catalyst system uses a precious metal oxidation catalyst to covert CO into CO₂

\[ \text{CO} + \frac{1}{2}\text{O}_2 \rightarrow \text{CO}_2 \]

CO Catalyst Requirements:
- Uniform velocity distribution within 15% rms
- Exhaust gas temperature entering at no greater than ±50°F

CO Catalyst can achieve 2-5 ppmv d@15%O₂, based on 95% reduction

CO Catalyst tolerate temperatures 425°F to 1150°F
- Increased oxidation (greater reactivity) at higher temperature
- Increased contamination rate below 650°F
• The SCR Catalyst system employs a catalytic reaction to convert ammonia (NH₃) and NOx into harmless water (H₂O) and nitrogen (N₂)

\[
4\text{NO} + 4\text{NH}_3 + \text{O}_2 \rightarrow 4\text{N}_2 + 6\text{H}_2\text{O}
\]

\[
\text{NO} + \text{NO}_2 + 2\text{NH}_3 \rightarrow 2\text{N}_2 + 3\text{H}_2\text{O}
\]

\[
6\text{NO}_2 + 8\text{NH}_3 \rightarrow 7\text{N}_2 + 12\text{H}_2\text{O}
\]

• SCR Catalyst Requirements:
  • Uniform velocity distribution within 15% rms
  • Exhaust gas temperature entering at no greater than ±50°F

• SCR Catalyst can achieve 2-5 ppmvd@15%O₂, based on 95% reduction
• SCR Catalyst cost and durability are sensitive to operative temperature
Ammonia Systems for SCR Catalysts

- Ammonia systems for anhydrous or aqueous supply
  - Aqueous ammonia (19% typical) requires larger equipment, greater power consumption, and more constant supply deliveries
  - Anhydrous ammonia requires increased safety measures and risk management

- Ammonia vaporization systems designed for exhaust gas recirculation or ambient air electric heaters

- Ammonia Injection Grid design influences NOx reduction and ammonia slip

- Ammonia slip of 2-10 ppmvd@15%O₂
Simple Cycle Emission Control Solutions

Flow Modeling Critical to Project Success

- VPI CFD Engineering uses Fluent software for flow analysis
- Turbine exhaust flow profile
- Duct design and distribution grid requirements
  - Focus on reducing gas side pressure drop
- Dilution Air mixing
- Ammonia Mixing

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Combined Cycle Emission Control Solutions

New CT and HRSG Installation

- Vogt Power has over 500 HRSG installations operating in 35 countries around the globe, both utility and industrial
- Design for combustion turbines 25 MW to 290 MW
- Proven design for high cycling and CT fast startup
Combined Cycle Emission Control Solutions

Adding Steam Cycle to Simple Cycle CTs

- Design experience for sighting HRSG into existing plants
- Both horizontal and vertical gas flow designs, including Once Through
Combined Cycle Emission Control Solutions

Existing Combined Cycle Installation Without Emission Catalysts

• Vogt Power Aftermarket provides parts and service to all OEM units
• Expertise in HRSG thermal re-rating due to CT upgrade/rerate
• Proven experience installing emission catalyst into existing units
Steam Injection for CT Emission Control Solution

Existing CT Installation

• Can provide heating surface for generating steam to be injection to CT for NOx control and power augmentation

• Can also integrate emission catalyst as necessary
Emission Control Durability

CO and SCR System Maintenance Concerns

- Poor quality NH3 fouling the control skid, vaporizer, AIG
- Catalyst poisoning due to high sulfur in CT exhaust, impurities in fuel supply or evaporative cooling water, or CT ingestion of dirty air
- Catalyst damage due to over-temperature, water washing, or casing insulation failure